AMERICAN SOCIETY FOR ENGINEERING EDUCATION

2017 ASEE Mid Atlantic Section
Spring Conference: Morgan State University, Baltimore, Maryland Apr 7 Paper ID #20823

Incorporating Undergraduate Research Experiences in an Engineering Technology Curriculum

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This paper describes a pedagogical model that integrates Course-based Undergraduate Research Experiences (CUREs) in an engineering technology course. The model aims to create experiences intended to enculturate students into developing basic practices for scientific investigation. And, at the same time, it seeks to provide opportunities to develop practical workforce skills for the computer technology field. Here we present the results from a pilot implementation. The effectiveness of the model has been evaluated by an external certification exam that validates foundational skills and knowledge required in entry-level job positions in the Information Technology field. The mean passing rate and mean exam's score of our students overpassed those of students from New York State and the country. We believe that this is a practical course model can be easily replicated by programs with the same interest.

I. Introduction

Undergraduate research is a high-impact practice leading to student success, engagement, interest in higher education, and skills development [1] [2]. There are two well-known models for incorporating research experiences in a program: Undergraduate Research Experiences (UREs) and Course-based Undergraduate Research Experiences (CUREs) [3]. UREs represent the apprentice model. They feature individual students in faculty research laboratories and provide the opportunity for one-on-one mentoring. On the other hand, CUREs are embedded into the curriculum and are available to most students, putting high demands on one or a few mentors to guide many students. UREs and CUREs vary in selectivity, duration, setting, mentoring, and cost [4].

One shortcoming of the apprenticeship model is scale-up; at most a faculty member can typically impact a handful of students each semester. On the other hand, incorporating CUREs into the curriculum is an approach for providing students with an undergraduate research experience and its benefits in a more broadly way. Under a typical CUREs model, students enroll in a course. The course, includes the inquiry/investigation materials as part of its curriculum, as alternatives or replacements for laboratory experiences where students verify known experiments. The curriculum aims to guide students in explicit stages of research and culminates in a paper or poster. Mentoring is charged to the course instructor and sometimes peers. Most CUREs implementations involve lower-division students and last for one semester of less. On the other hand, most UREs implementations typically involve upper-division students [5].

We believe that in engineering technology undergraduate programs CUREs and UREs should complement each other. CUREs should be included across the curriculum and at different levels. Our view is to incorporate basic research skills in early semesters and keep cultivating and expanding them as students move up. We believe that with this approach upper-level students will be better prepared to be part of UREs and have a more productive research experience.

This paper presents a particular case of integrating CUREs within an introductory course to computer hardware systems in a 2-year associate degree program. The course model presented here aims to create experiences intended to enculturate students into developing basic practices for scientific investigation. While, at the same time, the project seeks to provide opportunities to develop practical workforce skills for the computer technology field. Here, we discuss the details of the course's pedagogical model, the implementation, and the course assessment. The students' results from an external certification exam overpassed our expectations; our students' scores are higher than the scores of other colleges' students from New York State and the rest of the country.

The rest of paper is organized as follows. Section II provides information about the college, program, course, and the project. Section III provides the pedagogical background. We discuss, in Section IV, the goals and objectives of the project. The course pedagogical model and its implementation are described in Section V. The assessment and results are presented in Section VI. Finally, Section VII presents our conclusions and future work.

II. General background

New York City College of Technology (City Tech) is the designated college of technology of The City University of New York (CUNY), offering both baccalaureate and associate degrees. City Tech serves the city and the state by providing technically skilled graduates in the technologies of the arts, business, communications, health and engineering; human services and law-related professions; technical and occupational education; and liberal arts and sciences.

The CUREs initiative at City Tech

The CUREs initiative at City Tech aims to provide support for full-time research-active faculty and adjunct faculty with industrial experience. Thus, faculty works together to develop, implement and evaluate CUREs emphasizing workforce skills, into at least one course in each of the college's associate degree programs (AAS) accredited by the Engineering Technology Accreditation Commission of ABET. The project aims to build on what is already known about effectively implementing CUREs in the development of new curricular materials, especially in sciences [3]. It aims at creating a mutually supportive working relationship between full-time and adjunct faculty and provides mentoring to the adjunct faculty member on curriculum development and pedagogical strategies. Several programs have tried different approaches to

implementing CUREs. This paper focuses on one particular implementation, which was carried out in the AAS in Electromechanical Engineering Technology (EMT) Program.

The EMT program at City Tech is the only one of its kind within the CUNY system. Developed in response to the New York needs, this program prepares technicians with special skills needed by the computer and electromechanical industry. The program follows a multidisciplinary approach; students learn the fundamentals of electrical and mechanical technology, computers, and data communications and networking. Graduates can diagnose and analyze electromechanical problems associated with the development, performance, and servicing of computers and computer-based equipment, complex electromechanical industrial equipment and systems, and robotics.

For this CUREs implementation, the selected course is EMT2370: Computer Hardware Systems, this is a third-semester course. The course's main goal is to help the students understand the function and relationship of different computer components such as the CPU, memory, and peripheral equipment such as monitors, disk drives, scanners, and printers. The course learning outcomes are listed below [6]. Upon completing this course, the learner will be able to:

- Setup and configure a new computer.
- Given a scenario, select the appropriate components for a custom PC configuration, to meet customer specifications or needs.
- Install or upgrade the operating system.
- Install, configure, and manage common peripheral devices and multifunction device/printers.
- Troubleshoot common problems related to internal components such as motherboards, RAM, CPU, and power with appropriate tools.
- Troubleshoot common computer problems that can be resolved without replacing internal components.
- Install and configure a Small-Office/Home-Office (SOHO) wireless/wired router and apply appropriate settings.

The course learning outcomes reflect critical workforce skills needed for positions in the field of computer support. An entry-level position in the area of information technology (IT) support requires working knowledge of computers and mobile devices repair and maintenance, and basic principles of computer networks. A computer technician should be able to setup and configure a new computer and, given a scenario, select the appropriate components and peripherals for a custom PC configuration, to meet customer specifications or needs [7]. The technician should have the skills to troubleshoot common problems related to internal components such as motherboards, RAM, CPU, and power with appropriate tools. Also, troubleshoot common computer problems that can be resolved without replacing internal components, for example installing or upgrading drivers or operating system.

About technical certifications

EMT2370 course material is chosen for relevance to industry certification exams such as **CompTIA A+** [8]. A+ is a comprehensive and vendor-neutral certification that validates foundational skills and knowledge in troubleshooting, networking, and security across a variety of computing devices. A+ establishes best practices to set the stage for IT careers. The certification also matches professional tech skills with communication skills [7].

An alternative to A+ is the **TestOut PC Pro** Certification [9]. PC Pro also focuses on validating job skills required in the IT field. This is a 100% performance-based certification that measures not just what the student knows, but what the student can do. To obtained the certification the candidate must have practical knowledge of setting up, configuring, and managing system components, peripheral devices, computer networks, printers, mobile devices, and Windows system management and security [10]. This certification, although less recognized, can be an alternative to A+.

III. Pedagogical background

The **Knowledge Integration Framework (KIF)** is a socio-cognitive view that has been refined in empirical studies for more than 20 years by researchers at the University of California-Berkeley [11] [12]. Knowledge integration instruction emphasizes prediction, eliciting students' ideas from their background knowledge, about a science phenomenon. It also emphasizes on giving students the opportunity to add new ideas about science phenomena, by observation or experimentation. Thus, in activities under this framework, students are encouraged to compare their ideas and the associated evidence, negotiating criteria for what makes some ideas more explanatory than others. According to KIF authors, these activities provide opportunities for students to link new knowledge to their background knowledge. Investigating and explaining how their ideas connect, or bump up against each other, is essential for integrating new ideas into their repertoire of science concepts.

The Predict, Experiment, Explain and Reflect pattern

The KIF authors have developed the Web-based Inquiry Science Environment (WISE), a research-based digital learning platform that fosters exploration and science [13]. According to the site [14], WISE has served a growing community of thousands of science teachers, curriculum designers, and researchers, as well as over a hundred thousand K-12 students around the world [15]. WISE projects revolve around key conceptual difficulties that students encounter in biology, chemistry, and physics and are specifically tailored for classroom use. Thus, WISE projects offer a focused and inquiry-rich supplement to teacher's core scope and sequence. The WISE project keeps on the KIF; some of its projects follow the **POER (Predict, Observe, Explain, and Reflect)** pattern. The POER pattern guides students' interpretation of the content material [16]. Students write and justify predictions, describe observations of data collected, use

evidence to explain changes to their predictions, and reflect about their misunderstanding or misinterpretations, about what they learned, about what want or need to learn [17].

IV. Project goals

As mentioned before, the main aim of the CUREs initiative at City Tech is to explore alternatives for integrating CUREs that simultaneously help to develop workforce skills. Within the selected course in the EMT program, the CUREs implementation has the following goals:

- Create experiences intended to enculturate students into developing basic practices for scientific investigation within the computer technology field.
- Make students participate in basic scientific practices such as modeling of scientific observations, or analysis of data and documenting results;
- Provide a framework for students to develop logical reasoning for following a systematic approach for troubleshooting, maintaining, and repairing of computer hardware systems; and
- Provide opportunities to develop practical workforce skills for the computer technology field.

Note that this implementation is different from traditional CUREs implementations. In traditional CUREs, students select a topic or experiment to develop a poster or paper, which students present at the end of the semester. Here, we aim to provide several opportunities to the students to develop the scientific and experimental practices that would help them to be better prepared for doing research as part of UREs in the last semesters. Ideally, for this type of CUREs implementation, several courses in a different semester and at various levels should be doing the same. However, an implementation at that scale is beyond of the scope of this paper.

V. Course pedagogical model and implementation

For our CUREs implementation in the EMT2370 course, the laboratory projects have been developed following a pattern similar to POER. We add an **experiment** step where they have to do a hands-on activity based on a practical scenario. We call it **POEER (Predict, Observe/Experiment, Explain, and Reflect)** and is depicted in Figure 1.

Figure 1. The POEER pattern

The **POEER** pattern based lab exercises guide students for writing and justifying predictions, describe observations of data collected by well-designed experiments, use evidence to explain the results of their experiment results, the process they followed, their observations, and changes

to their predictions. Also, students reflect on their performance and their current understanding of the concepts explored.

To achieve the goals stated in the previous section, we have included three elements in the pedagogical model followed by this course:

1. **Using a simulator along with real hardware** to create new practical experiences that will develop the students' workforce skills needed for an entry-level job as computer repair technician or IT helpdesk, and to obtain a certification in the field. For this element, we use the **TestOut PC Pro 5.x** simulator and courseware.
2. **Incorporate the Knowledge Integration Framework trough the POEER pattern** to provide a systematic and scientific approach for:
   i. Understanding the functionality and relationship of the different components that form a computer and a computer network, and
   ii. Learning to conduct experiments and reports that would improve computer troubleshooting related skills.
3. **A flipped classroom model** where the students, as homework, have to review selected topics from the course and practice using the simulator. Thus, in class time, the instructor briefly reviews the topics, and the review is followed by a technical knowledge assessment (short multiple choice quizzes) and by a practical evaluation (hands-on lab experiments).

Simulators versus hardware

The best way to learn about computer support and repair and networking topics is by hands-on experiences. However, setting up a personal training lab would require the components needed to at least build a couple of different computers (various types of motherboards, processors, memory, and more), a switch, and a router to network these computers. Hands-on labs exercises with real equipment are great; however, their experience would be limited to the number of devices in the lab. [18]. Additionally, a school would need several of these personal training labs, which might be expensive and requires maintenance.

Simulators such as TestOut's LabSim are an excellent alternative to real equipment training. Simulators often come with predefined scenarios where students have to configure equipment or troubleshoot problems very similar to what a technician would face in a real case. Additionally, some simulators grade the labs and provide feedback, which helps students to learn from their mistakes [19]. CompTIA and CISCO use simulators in their certification exams [20]. Moreover, simulators are way cheaper than real hardware and save the physical space required by hardware and cables [21].

Despite the number of benefits of using a simulator, some physical and motor skills can only be learned by using the actual hardware, by practice. For example, some these skills are using a screwdriver or perfectly collocating a real processor into the motherboard socket. For these

reasons and more, we propose to use the best of both worlds, incorporating several simulator-based labs along with some real hardware lab experiments.

The POEER based labs

Each lab exercise starts describing a realistic scenario, a problem that resembles real problems technicians face at their jobs. For example, in the first lab scenario of this course, the student pretends to work for a nearby to the school computer repairing shop and is required to build a new computer for a customer. In other lab scenarios, the student works as the IT administrator of a small corporate network. In some of the scenarios, the student has to troubleshoot, install, or configure computers, servers, mobile devices and other peripherals, which might be connected to a computer network.

After the scenario is introduced, the first section the students have to complete is the **Predict section**. This section captures the student prediction about how to solve the problem in the scenario, based on what they already know. Thus, students try to use all their current knowledge to predict what actions they should take. This section's goal is to make the students bring their background knowledge up front and write about it.

The section **Observe/Experiment** is the hands-on part where students have to do a quantitative experiment, troubleshoot a system, or build something. Some labs would require collection and analysis of data. This section is where the simulator and the hardware play the main role. The section might present some instructions about how to achieve some of the goals or to solve some parts of the problem, and it states the expectations clearly.

The **Explain** section is where the student explains how s/he solved the problem. To answer this section, we ask the students to imagine that they are trying to explain what they did to their boss, what the problem was, and how it was solved. Students should assume that their boss knows about computer hardware and the current subject. Thus, they should use the correct language and the right terminology. Some labs ask the students to write a procedure to solve the problem they solved, assuming that the procedure would become part of the company's documentation and training for other technicians. Some labs require collecting data from the conducted experiment. Students most format the data in tables and charts and present an analysis explaining the meaning of the data. This section aims to make the students put together their ideas and tie them to their background knowledge to become part of its permanent knowledge.

Finally, in the **Reflect** section, students describe the knowledge they acquired from the lab or experiment and how they can apply it to other scenarios. Usually, students have to mention what they learned and how it complements something they already knew. Also, they have to share how their view or ideas changed after they completed the lab. Finally, sometimes, we ask their opinion about the lab assignment; what they liked or did not like, or some ideas to improve the

lab. This section makes students talk about of their experience, adding an auto critic, and help us to know how to improve the labs.

Flipped classroom

The instructional strategy known as flipped classroom is a type of blended learning that reverses the traditional learning environment. The flipped classroom model delivers instructional content, often online, outside of the classroom. At home, students watch online lectures, collaborate in online discussions, or carry out research. On the other hand, activities that traditionally can be considered homework are moved into the classroom. Thus, in the classroom, students engage in practical activities and discussions with the guidance of a mentor [22].

Since the TestOut's PC Pro courseware was adopted as a replacement for a regular textbook, the implementation of the flipped classroom approach was easier. The courseware includes, professionally design and edited instructional videos, which include nice scripts, labs in the online simulator, and review quizzes. As weekly take home assignments, students have to review carefully selected sections of the courseware. To assess that they actually complete the assignments, we count as part of their final grade both, the average grades of online labs and the average grades of quizzes at the end of each section assigned. Students can take the quizzes and the labs as many times as they need to pass them. However, the minimum passing grade is 80%. Thus, the course grading policy is as follows:

- **Homework assignments: 50%**
  - Quizzes: 25%
  - Labs: 25%
- **In-class assignments, labs, and exams: 50%**
  - Weekly in-class quizzes: 10%
  - In-Class Labs (POEER): 20%
  - Mid-Term Exam: 10%
  - Final Exam: 10%

For the in-class lectures and activities, we have created a set of instructor's PowerPoint slides for the weekly topics, the weekly quizzes in Blackboard format, and a lab manual. The laboratory manual includes twelve hands-on, customized lab exercises. It includes five hardware-based labs and seven simulator-based labs.

VI. Assessment and results

For this implementation, we have set the ambitious goal to prepare the students to get the TestOut PC Pro certifications at the end of the course, as the final exam. Thus, the CUREs implementation and the course has been assessed based on the results of the PC Pro certification exam. As mentioned before, the TestOut PC Pro Certification is a real 100% performance-based certification—a certification that measures not just knowledge, but practical skills. This

certification is comparable with the CompTIA A+. We select PC Pro instead of A+ because students are qualified to get a voucher when they purchase the corresponding account access for PC Pro courseware. We believe that the PC Pro certification exam is an appropriate instrument to evaluate the impact of both cognitive and not cognitive skills. In particular, to assess the incidence of the research skills we added in the labs in developing practical workforce skills.

The results

The PC Pro Certification exam has a time limit of 120 minutes and contains about 15 performance based simulation questions that count up to 50 different tasks [9]. The passing score for the certification exam is 1360 on a scale of 200-2000. The results of the exam can be compared to the school, the state, and the country. The TestOut system provides, to the instructor only, detailed results by topic and by the student.

Table 1. Comparison of the PC Pro certification exam's results

	Mean	Pass Rate	Completion Time
EMT2370 (Fall 2016-D438)	**1789.09**	**100.00%**	1:18
Colleges (NY)	1462.32	82.57%	1:13
Colleges (USA)	1408.91	80.30%	1:11

For the first implementation of this model, we aim at a 50% passing rate. The results overpassed our expectations. The passing rate of our students was 100% (n=22), as shown in **Table 1**, which is higher than the NY state and national passing rate. When compared to other students from other colleges, our students have a higher mean exam score (1789) than other college students in NY (1462) and in the country (the national mean score is 1409). The difference is remarkable; this perhaps indicates that our students have better practical skills to solve the problems in the exam.

VII. Conclusions

The course's pedagogical model presented here is a feasible model for implementing CUREs across the curriculum. This model can be used for creating experiences intended to enculturate students into developing basic practices for scientific investigation and developing logical reasoning for following a systematic approach for troubleshooting. At the same time, the model provides opportunities to develop practical workforce skills, in this case, for the computer technology field. We believe that the POEER pattern, used for the lab assignments design, in combination with the use of hardware and simulators have a strong impact on the learning process of the students. The in-class, POEER based, lab assignments keep the students interested

and excited; they have productive dialogues that allow them interchange knowledge and expertise. In addition, the adoption of the TestOut PC Pro courseware, instead of a regular textbook, makes easy the flipped classroom approach. The results from the PC Pro certification exam were better than expected. As a pilot, we expected a modest 50% passing rate; however, all the students passed the exam and got the certification. The passing rate was not the only surprise; the average student's grade overpassed the results from other colleges both, from New York State and nationwide.

Commonly, the prevailing belief has been that cognitive abilities mattered more than non-cognitive skills for predicting academic and workforce success. However, the latest research suggests that both skill sets play a major role in determining success [23]. We believe that the CUREs model we implemented has helped the students to obtain the workforce skills expected to have, from the course learning outcomes, and perhaps some other soft skills. This pedagogical model also helps other aspects of general education such as a commitment to quality, timeliness, and continuous improvement. Moreover, in this particular implementation, since we are targeting a professional certification, students get an understanding and the ability to engage in self-directed continuing professional development. These outcomes, represent some program outcomes that accreditation organizations for engineering, such as ABET, require.

We believe that the course model presented here is practical and can be replicated easily by other colleges with similar courses or interests. The results presented here are from a pilot; the next step is scalability. During the coming semester, two sections of the same course, with different instructors, will follow the course model presented here. We expect similar results.

VIII. References

[1] D. Lopatto, "Undergraduate Research as a High-Impact Student Experience," *Peer Review,* vol. 12, no. 2, 2010.

[2] K. Yaffe, C. Bender and L. Sechrest, "How Does Undergraduate Research Experience Impact Career Trajectories and Level of Career Satisfaction: A Comparative Survey," *Journal of College Science Teaching,* vol. 44, no. 1, pp. 25-33, 2014.

[3] L. C. Auchincloss, S. L. Laursen, J. L. Branchaw, K. Eagan, M. Graham, D. I. Hanauer, G. Lawri, C. M. McLinn, N. Pelaez, S. Rowland, M. Towns, N. M. Trautmann, P. Varma-Nelson, T. J. Weston and E. L. Dolan, "Assessment of Course-Based Undergraduate Research Experiences: A Meeting Report," *CBE Life Sci Educ,* vol. 13, no. 1, pp. 29-40, 2014.

[4] M. C. Linn, E. Palmer, A. Baranger, E. Gerard and E. Stone, "Undergraduate research experiences: Impacts and opportunities," *Science,* vol. 347, no. 6222, 2015.

[5] M. K. Eagan, S. Hurtado, M. J. Chang, G. A. Garcia, F. A. Herrera and J. C. Garibay, "Making a Difference in Science Education: The Impact of Undergraduate Research Programs," *American Educational Research Journal,* vol. 50, no. 4, pp. 683-713, 2013.

[6] B. Mendoza, "EMT2370: Computer Hardware Systems," Computer Engineering Technology Department at City Tech, August 2016. [Online]. Available: https://openlab.citytech.cuny.edu/emt2370/syllabus/. [Accessed 1 March 2017].

[7] M. Meyers, Mike Meyers' CompTIA A+ Guide to Managing and Troubleshooting PCs, McGraw-Hill Education, 2016.

[8] "CompTIA A+ Certification," CompTIA, [Online]. Available: https://certification.comptia.org/certifications/a. [Accessed 4 March 2017].

[9] "TestOut PC Pro Certification," TestOut, [Online]. Available: http://www.testout.com/home/certification/testout-pc-pro-certification. [Accessed 12 February 2017].

[10] "TestOut PC Pro Objectives," TestOut, [Online]. Available: http://www.testout.com/home/certification/testout-pc-pro-certification/pc-pro-objectives. [Accessed 4 March 2017].

[11] M. C. Linn, "Designing computer learning environments for engineering and computer science: The scaffolded knowledge integration framework," *Journal of Science Education and Technology,* vol. 4, no. 2, 1995.

[12] R. T. White and R. Gunstone, Probing Understanding, New York, NY: Routledge , 1992.

[13] M. C. Linn, C. Douglas and J. D. Slotta, "WISE design for knowledge integration," *Science Education,* vol. 87, no. 4, 2003.

[14] "WISE: Web-based Inquiry Science Enviroment," University of California at Berkely, [Online]. Available: https://wise.berkeley.edu/. [Accessed 4 March 2017].

[15] L. F. Gerard, K. Varma and S. Corliss, "Professional Development for Technology-Enhanced Inquiry Science," *Review of Educational Research,* vol. 81, no. 3, pp. 408-448, 2011.

[16] "The WISE Virtual Learning Environment," University of California at Berkely, [Online]. Available: https://wise.berkeley.edu/pages/features.html. [Accessed 4 March 2017].

[17] L. F. Gerard, M. Spitulnik and M. C. Linn, "Teacher Use of Evidence to Customize Inquiry Science Instruction," *Journal of Research in Science Teaching,* vol. 47, no. 9, pp. 1037-1063, 2010.

[18] L. Sun, J. Wu, Y. Zhang and H. Yin, "Comparison between physical devices and simulator," in *The 8th International Conference on Computer Science & Education (ICCSE 2013)*, Colombo, Sri Lanka, 2013.

[19] J. Janitor, F. Jakab and K. Kniewald, "Visual Learning Tools for Teaching/Learning Computer Networks: Cisco Networking Academy and Packet Tracer," in *Sixth International Conference on Networking and Services*, Cancun, Mexico, 2010.

[20] W. Odom, "Sim vs Em vs Real," Wendell Odom's CertSkills, 2016. [Online]. Available: http://www.certskills.com/clioptions/SimvsEmvsReal.aspx. [Accessed 2 March 2016].

[21] B. Mendoza, "On Using Simulators and a Hybrid Approach for an Internetworking Technology Course," in *Spring 2016 Mid-Atlantic ASEE Conference, April 8-9, 2016 GWU*, Washington, DC, 2016.

[22] L. Santos Green, J. R. Banas and R. A. Perkins, The Flipped College Classroom: Conceptualized and Re-Conceptualized, Cham, Switzerland: Springer, 2017.

[23] P. C. Kyllonen, "Soft Skills for the Workplace," *Change,* vol. 45, no. 6, pp. 16-23, 2013.